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TECHNICAL MEMORANDUM

DATE: June 25, 2024

Project No.: 941-80-23-33
SENT VIA: EMAIL

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SUBJECT: Design of Projection Scenarios to Support the 2025 Safe Yield Reevaluation (#3)

This technical memorandum (TM) is the third of three TMs that document the development of an ensemble of projection scenarios (Projection Ensemble) for the 2025 Safe Yield Reevaluation (2025 SYR).

The objective of the Projection Ensemble is to characterize the range in future uncertainties in climate and the water demands and supply plans (Water Plans) of the water purveyors in the Chino Basin, pursuant to Steps 3 through 5 of the 2022 Safe Yield Reset Methodology:[1]

3. Describe current and projected future cultural conditions, including but not limited to land use and water-management practices, such as: pumping, managed recharge, managed groundwater storage, impervious land cover, water recycling, and water conservation practices. Identify a possible range of projected future cultural conditions.
4. Using the most current research on future climate and hydrology, identify a possible range of projected future climatic conditions in the Santa Ana River watershed.
5. Using the results of [3.] and [4.] above, prepare an ensemble of multiple projection scenarios of combinations of future climate/hydrology and cultural conditions (herein called the "Projection Ensemble"). Assign likelihoods to each scenario in the Projection Ensemble.

The Projection Ensemble will be simulated with the Chino Valley Model (CVM) to characterize the future uncertainties of the hydrology, net recharge, and Safe Yield of the Chino Basin.

The objectives of this TM are to (i) document the feedback received on Scenario Design TM #2 (Scenario TM #2)[2] and the March 7, 2023 stakeholder workshop (Workshop #2),[3] (ii) quantitatively describe various proposed projections of Water Plans that will be included in the Projection Ensemble, and (iii) describe the proposed approach to developing climate projections. The Watermaster parties and other stakeholders will be presented with the information documented in this TM at a workshop on June 25, 2024 and asked to provide feedback.

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[1] See Attachment C of the 2022 Update of the Chino Basin Safe Yield Reset Methodology

[2] Scenario Design TM #2

[3] Slides from Workshop #2

FEEDBACK FROM SCENARIO DESIGN TM #2 AND MARCH 7, 2024 WORKSHOP

Scenario TM #2 and Workshop #2 qualitatively described the proposed projections of the Water Plans to include in the Projection Ensemble, described the available and recommended climate datasets that may be included in the Projection Ensemble, and outlined the proposed Projection Ensemble to use in the 2025 SYR. Stakeholders were asked to provide written feedback on Scenario TM #2 and Workshop #2 to further refine the Projection Ensemble. The written stakeholder feedback and responses are included in Attachment A. The main themes of the stakeholder feedback are discussed below.

Characterization of Groundwater and Imported Water Conditions

Scenario TM #2 defined water demands, groundwater availability, and imported water availability as the three primary elements of Water Plans that will characterize the range in future uncertainties in Water Plans in the Projection Ensemble. Groundwater and imported water availability were defined as the ability of the parties to access, purchase, convey, and use these waters to meet their demands. During Workshop #2, several parties recommended that the definitions be expanded to include the "use" of groundwater or imported water more explicitly, because "availability" does not necessarily lead to the use of a supply. One party suggested characterizing these elements as groundwater/imported water utilization rather than availability. This suggestion will be reflected in discussions of these elements of the Projection Ensemble going forward. The definitions of expected, high, and low conditions for groundwater and imported water utilization remain unchanged from those described in TM #2.

FINAL PROJECTION ENSEMBLE

This section describes the final Projection Ensemble and the proposed quantification of each of its scenarios. Based on the feedback from Scenario TMs #1 and #2 and Workshops #1 and #2, we propose the final Projection Ensemble shown in Table 1. These nine scenarios, comprising a combination of three Water Plan scenarios and three climate scenarios, synthesize the "possible range of projected future cultural conditions" and "possible range of projected future climatic conditions" required in the 2022 Safe Yield Reset Methodology.[4]

Table 1. Projection Ensemble

Scenario	Rationale	Demand	Groundwater Utilization	Imported Water Utilization	Climate Scenario
1	Expected/baseline	Expected	Expected	Expected	Expected
2	Hot/dry climate	Expected	Expected	Expected	Hot/dry
3	Cool/wet climate	Expected	Expected	Expected	Cool/wet
4	Impact of high demands	High	High	Low	Expected
5	Low groundwater levels	High	High	Low	Hot/dry
6	High net recharge	High	High	Low	Cool/wet
7	Impact of low demands	Low	Low	High	Expected
8	Low net recharge	Low	Low	High	Hot/dry
9	High groundwater levels	Low	Low	High	Cool/wet

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[4] See Attachment C of the 2022 Update of the Chino Basin Safe Yield Reset Methodology

Scenario 1 is the "baseline" scenario that will simulate expected conditions for all Water Plans and future climate/hydrology.

Scenarios 2 and 3 are modifications to Scenario 1 that will simulate the effects of a hotter/drier climate (2) and cooler/wetter climate (3). Together, these scenarios will characterize the effects of future climatic uncertainty on net recharge and groundwater levels.

Scenarios 4 and 7 are designed to characterize the effects of future uncertainty in Water Plans on net recharge and groundwater levels.

Scenarios 5 and 9 are designed to simulate the plausible range in groundwater levels. Scenario 5 assumes high demands, high groundwater utilization, low imported water utilization, and a hot/dry climate, which will likely result in the lowest groundwater levels of any combination. Conversely, Scenario 9 assumes low demands, low groundwater utilization, high imported water utilization, and a cool/wet climate, which will likely result in the highest groundwater levels of any combination.

Scenarios 6 and 8 are designed to simulate the plausible range in net recharge. Scenario 6 assumes high demands, high groundwater utilization, low imported water utilization, and a cool/wet climate, which will likely result in the highest net recharge of any combination. Conversely, Scenario 8 assumes low demands, low groundwater utilization, high imported water utilization, and a hot/dry climate, which will likely result in the lowest net recharge of any combination.

Other possible combinations of Water Plan scenarios and climate scenarios are unlikely to result in conditions (e.g., net recharge, groundwater levels) that are outside of the range of the scenarios described in Table 1.

PROCESS TO TRANSLATE THE WATER PLAN SCENARIOS INTO 2025 CVM INPUTS

The process to translate the Water Plan scenarios into inputs for the 2025 Chino Valley Model (CVM) involves first developing the Water Plan scenarios for average hydrologic conditions and then adjusting the annual Water Plans based on interannual variability in climate (precipitation and temperature). This process will be guided by the following questions:

1. Which model inputs will vary for each Water Plan scenario?
2. What are the current plans, projections, and assumptions for future cultural conditions in the Chino Basin?
3. How should the current plans and projections be modified to develop Water Plan scenarios that will represent the uncertainty in future cultural conditions?
4. How should the Water Plan scenarios be adjusted to account for climatic variability?

Each of these questions is addressed in the following sections.

CVM Inputs that Will Vary in Each Water Plan Scenario

This section answers question 1 above: *Which model inputs will vary for each Water Plan scenario?*

Understanding how the cultural conditions translate into model inputs is important to guide the level of detail required for the development of each projection scenario. The scenarios in the Projection

Ensemble will be translated to CVM inputs as demonstrated in the flowchart in Figure 1. The Water Plan scenarios influence three CVM inputs:

- **Deep infiltration of precipitation and applied water (DIPAW).** DIPAW is calculated by the R4 model, which is part of the CVM, and is translated into groundwater recharge via the recharge (RCH) package of MODFLOW, the groundwater-flow model of the CVM. Changes in land use, population, water demands, and climate drive changes in DIPAW.
- **Groundwater pumping.** Groundwater pumping is based on the Water Plan scenarios and fluctuate from year to year based on demands. Groundwater pumping is implemented in the well (WEL) and multi-node well (MNW2) packages of MODFLOW.
- **Managed aquifer recharge.** Managed aquifer recharge includes the recharge of stormwater, recycled water, and imported water. Stormwater recharge varies based on precipitation conditions and the extent and operation of facilities to capture and recharge stormwater. Recycled water recharge varies based on water supply conditions, indoor water use patterns, and the operations, economics, and other constraints governing the ability to recharge recycled water. Imported water recharge is based on the assumed use of managed storage in the Chino Basin, which responds to groundwater pumping, net recharge, and the parties' choices of how to meet replenishment obligations. In addition, imported water can be recharged via Storage and Recovery Programs. Imported water recharge is implemented in the flow and head boundary (FHB) package of MODFLOW.

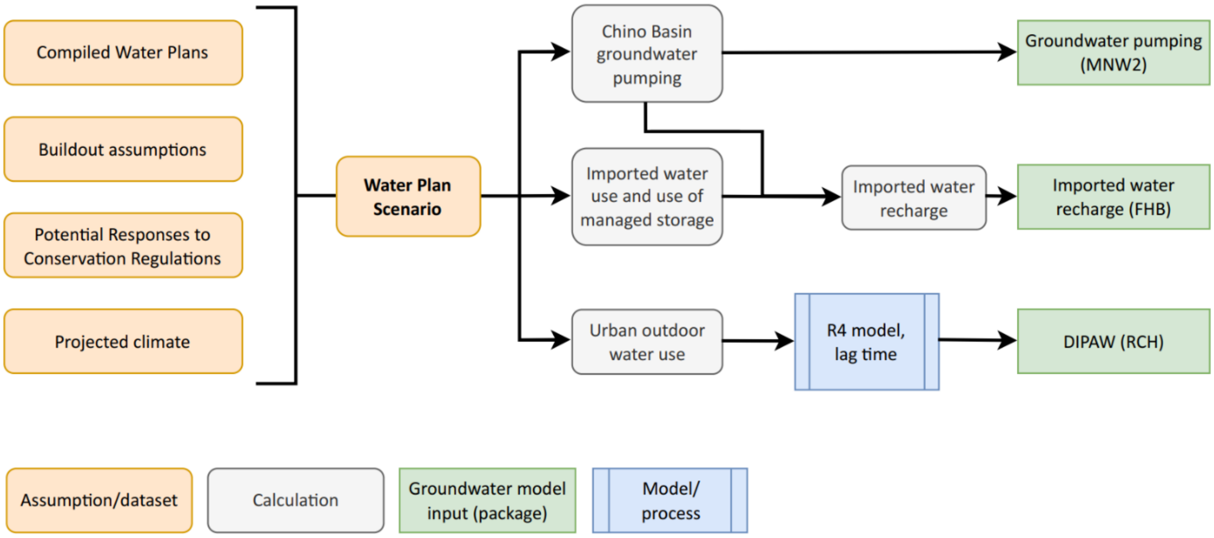

Figure 1. Process to translate Water Plan scenarios into groundwater model inputs for the 2025 SYR.

Current Plans, Projections, and Assumptions for Future Cultural Conditions

This section answers question 2 above: *What are the current plans, projections, and assumptions for future cultural conditions in the Chino Basin?*

The current plans, projections, and assumptions for future cultural conditions will form the basis for the Water Plan scenarios. Most of the data and information described in this section were collected from the Chino Basin parties. The following subsections discuss the datasets and assumptions that inform the Water

Plan scenarios, including historical water uses, Water Plans, buildout timeline, timeline for implementing water conservation regulations, and the use of managed storage and supplemental water recharge.

Historical Water Uses

Figure 2 depicts the historical water-supply data compiled from Water Year (WY) 2015 through 2023 for the Chino Basin parties. Over this period, total water demand ranged from 272,000 af (in WY 2023) to 307,000 af (in WY 2020) and averaged about 292,000 afy.

Historical water supplies vary depending on hydrologic conditions. The nine-year period experienced three years that were wetter than average (wet years; WYs 2017, 2019, and 2023), with the other six years experiencing below-average precipitation (dry years). Chino Basin groundwater comprises about 47 percent of supplies in wet years, and about 51 percent of supplies in dry years, averaging 49 percent. Imported water comprises about 22 percent of supplies in wet years, and about 20 percent of supplies in dry years, averaging 21 percent.

Compiled Water Plans

As part of the annual data collection and evaluation process, Watermaster requests updated Water Plans from the major Appropriative Pool retailers (AP retailers) and the larger Overlying Non-Agricultural Pool parties. For many of the Appropriative Pool retailers, the Water Plans are based on their respective 2020 Urban Water Management Plans (UWMPs). Watermaster worked with the AP retailers to develop monthly Water Plans and determine the priority of supplies that will be used to meet demands when projected water supplies exceed demands. The AP retailers included:

- City of Chino (Chino)
- City of Chino Hills (Chino Hills)
- City of Norco (Norco)
- City of Ontario (Ontario)
- City of Pomona (Pomona)
- City of Upland (Upland)
- Cucamonga Valley Water District (CVWD)
- Fontana Water Company (FWC)
- Golden State Water Company (GSWC)
- Jurupa Community Services District (JCSD)
- Marygold Mutual Water Company (MMWC)
- Monte Vista Water District (MVWD)
- Santa Ana River Water Company (SARWC)
- San Antonio Water Company (SAWCo)
- West Valley Water District (WVWD)

The projected pumping for the Overlying Non-Ag Pool parties (excluding those also in the Appropriative Pool, such as Ontario and MVWD) was developed based on historical trends or the party's response to the annual data request. Excluding pumping from General Electric Company, which injects approximately the same volume of water that it pumps, the total projected pumping by the Overlying Non-Agricultural

Pool is about 1,430 afy. For simplicity and due to the generally stable nature of the demands of the Overlying Non-Agricultural Pool, we do not assume any variation in these projections.

Agricultural Pool demands are expected to reflect the trend of buildout across the Basin, declining as the Appropriative Pool agencies' service areas build out aligning with the potential buildout timelines discussed below. Watermaster has estimated the production of the Agricultural Pool at buildout based on historical data and projection of wells that are expected to pump in the future. In addition to the wells that are expected to pump at buildout, there are several agricultural areas that are irrigated by recycled water. Several of these areas are expected to remain in the future. Figure 3 shows the Agricultural Pool wells that are expected to produce in the future beyond buildout of the Basin and the projected pumping at these wells. The Agricultural Pool's total water use at buildout is expected to be about 4,070 afy. Uncertainty of the timing of decline in Agricultural Pool pumping is reflected in the timing of buildout discussed below.

Table 2 shows the aggregate Water Plan for the Watermaster parties and the Chino Desalter Authority for 2020[5] (actual data in year with highest historical demands) and projected Water Plans for planning years 2025 through 2045. The projected demands increase from 307,000 af in 2020 to 374,000 af in 2045. The projected utilization of Chino Basin groundwater (44 to 48 percent of total supply) is less than the historical utilization over the past nine years (49 percent). Conversely, the projected utilization of imported water (25 to 27 percent of total supply) is greater than the historical utilization over the past nine years (21 percent of total supply).

Table 2. Compiled Water Plans for the Watermaster Parties

Water Supply	2020[(a)]	2025	2030	2035	2040	2045
Volume (afy)						
Chino Basin Groundwater	151,365	143,179	155,712	163,446	175,211	179,016
Non-Chino Basin Groundwater	48,308	54,682	55,077	55,371	55,762	55,954
Local Surface Water	26,620	13,205	13,205	13,205	13,205	13,205
Imported Water	59,637	87,113	88,368	91,624	94,310	94,808
Recycled Water for Direct Use	20,857	25,891	27,888	29,185	30,782	31,282
Total	306,787	324,070	340,250	352,831	369,270	374,265
Percent of Total Supply						
Chino Basin Groundwater	49%	44%	46%	46%	47%	48%
Non-Chino Basin Groundwater	16%	17%	16%	16%	15%	15%
Local Surface Water	9%	4%	4%	4%	4%	4%
Imported Water	19%	27%	26%	26%	26%	25%
Recycled Water for Direct Use	7%	8%	8%	8%	8%	8%
Total	100%	100%	100%	100%	100%	100%

(a) Historical data compiled for Water Year 2020 for the Chino Basin SGMA Annual Report.

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[5] Compiled for Water Year 2020 for the Water Year 2020 Annual Report that Watermaster submitted to the State pursuant to the Sustainable Groundwater Management Act.

Buildout Timeline

Future population growth and land use are typically defined by buildout conditions, where a region approaches stable population and land uses. Most of the 2020 UWMPs for the Appropriative Pool parties indicate that respective service areas will be built out by 2040 or 2045. The parties incorporate these assumptions in their Water Plans, projecting increasing demands through at least 2040. Parties have also indicated that demands and land use conditions could change in the future in response to legislation incentivizing urban densification (i.e., changing land uses to increase population density). Future population growth rates, economic conditions, and other factors can also drive the buildout timeline. The best available data for buildout land use conditions are the cities' General Plans, which were used to develop projected future land use.

Conservation Regulation

Since 2018, the State Water Resources Control Board (State Board) and the Department of Water Resources (DWR) have been developing new water use efficiency standards for urban retail water suppliers to implement the 2018 Urban Water Use Objectives legislation (Assembly Bill 1668 and Senate Bill 606) and the related "Making Conservation a California Way of Life" (Conservation Regulation)[6]. In October 2023, the State Board released the first draft of the proposed Conservation Regulation. Following comments from the public, the State Board released a revised draft[7] in March 2024. Following additional public engagement, the State Board released revised drafts in May 2024[8] and June 2024,[9] both of which made only relatively minor changes. Comments on the most recent revisions will be accepted through July 1, 2024. The State Board is considering adoption of the Conservation Regulation on July 3, 2024;[10] if adopted this summer, the Conservation Regulation will take effect in January 2025 with compliance expected to be assessed beginning in 2027. If the State Board does not adopt final regulations by August 8, 2024, the State Board will have to reinitiate the rulemaking process. Therefore, we expect the Conservation Regulation to be adopted in 2024 in a form similar to the June 2024 draft.

The proposed Conservation Regulation requires the calculation of a budget for residential outdoor water use, incorporating a landscape efficiency factor linked to irrigable area, with future reductions slated for 2035 and 2040 to promote water-efficient landscaping practices. The State Board has compiled available data into a statewide database to estimate water use objectives for each water agency subject to the Conservation Regulation. The Chino Basin parties that would be subject to the Conservation Regulation have indicated significant uncertainty in their customers' responses to the Conservation Regulation and have voiced concerns with the State Board database. The State Board database calculates total water use objectives for each agency based on four components: (1) residential water use, including indoor, outdoor, and residential agriculture, (2) water losses, (3) outdoor irrigation for commercial, industrial, and institutional uses with dedicated irrigation

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[6] Making Conservation a California Way of Life Fact Sheet

[7] March 12, 2024 revised draft Conservation Regulation text; Making Conservation a California Way of Life Draft Regulation Revision

[8] May 20, 2024 revised draft Conservation Regulation text

[9] June 14, 2024 revised draft Conservation Regulation text

[10] July 2-3, 2024 Board Meeting Agenda (ca.gov)

meters (CII w/ DIMs), and (4) bonus incentives for potable recycled water use.[11] Changes in outdoor irrigation for (1) and (3) have the greatest impact on the groundwater basin and are therefore the focus for this study.

Following Watermaster's March 7, 2024 workshop, Watermaster solicited feedback from the parties regarding how to quantify the proposed projection scenarios, including projecting responses to the Conservation Regulation. No Appropriative Pool parties provided specific input on how to quantify responses to the Conservation Regulation. Our approach to quantify projected responses to the Conservation Regulation began with using the State Board database to develop initial estimates of the water use objectives for the parties that are subject to the Conservation Regulation. We met with four Appropriative Pool parties that are subject to the Conservation Regulation: Ontario, Upland, CVWD, and JCSD. The parties indicated that:

- The data upon which the water use objectives are based are generally accurate.
- The State Board database did not calculate a water use objective for CII w/ DIMs because the landscape area used in the calculation has not been generated yet; instead, the water use objective for CII w/ DIMs in the database reflects historical use. Parties indicated that once the water use objectives for CII w/ DIMs is calculated, it will likely be less than their current use, necessitating future reductions in water use from CII w/ DIMs. This would increase the total targeted reductions needed to meet the Conservation Regulation compared to the State Board database. CII water use is a small portion of most parties' water demands.
- The water use objectives for CII w/ DIMs will be easier to meet than residential water use objectives due to the higher proportion of non-functional turf in these areas.
- Many agencies hired an outside consultant to develop refined water use objectives compared to what the State has calculated, including calculating the budget for CII w/ DIMs. These data are unpublished, provisional, and will be updated as the Conservation Regulation continues to be refined.
- Areas that have been recently developed (e.g., Eastvale) or are in development (e.g., Ontario Ranch) are likely to have lower residential water use compared to existing areas.
- Agencies that will be required to reduce water use by greater than about 10-15 percent from current water uses will have trouble meeting these targets without external funding or assistance. However, if such funding or assistance were available, some agencies indicated that such reductions in water use could be possible.
- The compiled Water Plans generally do not reflect the projected impact of the Conservation Regulation. Agencies with access to imported water generally expect to reduce their usage of imported water to meet the Conservation Regulation. Upland indicated that they would reduce pumping from the Chino Basin rather than reduce use of imported water.

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[11] Indoor water use standards, codified at Water Code section 10609.4(a), were originally set by the State Legislature as a part of the Conservation Legislation and amended in 2022 following joint input from the State Board and DWR. The State Board initiated a separate rulemaking process for water loss performance standards, adopting the final regulation on August 19, 2022. Water Loss Performance Standards Regulatory Text

Estimated Implementation of Conservation Regulation for AP Retailers

Based on the current understanding of the Conservation Regulation, input from the parties suggests that the State Board database is appropriate for determining the future water use objectives for residential outdoor use, but its use for determining the future water use objectives for CII w/ DIMs is limited. For each of the nine major AP retailers,[12] we calculated the nominal water use objectives for residential water use based on either the State Board database or the data that the party provided, prioritizing the latter. The parties and the State Board database calculate water use objectives relative to historical uses, not accounting for population growth. These objectives can be converted to gallons per capita per day (gpcd) and multiplied by the projected service area population to calculate the total changes in water demands. All projections shown in this TM have been adjusted for projected population growth based on the population projections in the parties' 2020 UWMPs.

We also calculated the nominal objectives for CII w/ DIMs based on assuming a reduction of 20 percent in 2030, 35 percent in 2035, and 45 percent in 2040 and 2045 compared to historical uses. This timeline is based on the provisional data provided by several parties for their respective CII w/DIMs, which is consistent with the reduced landscape efficiency factors (LEFs) for CII w/DIMs.[13]

Use of Managed Storage and Supplemental Water Recharge

Pursuant to the Judgment, Watermaster levies and collects assessments each year in amounts sufficient to purchase replenishment water to replace pumping by a Pool during the preceding year in excess of that Pool's allocated share of Safe Yield (Overlying Agricultural and Overlying Non-Agricultural Pools) or Operating Safe Yield (Appropriative Pool). Each party's obligation is determined after accounting for any transfers or recovery of stored water. Parties within the Overlying Non-Agricultural Pool can transfer stored water and/or unused Safe Yield rights among themselves with Watermaster approval to minimize their replenishment obligations. Appropriative Pool Parties can do the same within their Pool. After the completion of a fiscal year, Watermaster collects pumping and transfer records from all parties to determine replenishment obligations created in the prior year.

Projected future replenishment obligations are based on current and projected Safe Yield, groundwater augmentation as described above, and the transfer activity among the parties. Prior projections (e.g., the 2020 SYR) have estimated replenishment obligations by comparing aggregate groundwater pumping to aggregate production rights. Aggregate production rights are based on the Safe Yield, Reoperation credits used to offset the Desalter Replenishment Obligation, and projected recycled water recharge credits allocated to the parties. The 2020 SYR used the following assumptions:

- If aggregate pumping rights are greater than the projected aggregate pumping, then the difference is credited to storage accounts and there is no wet-water recharge for replenishment.

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[12] These include Chino, Chino Hills, Ontario, Pomona, Upland, CVWD, FWC, JCSD, and MVWD.

[13] The LEF is "a factor used to calculate the aggregate amount of water a supplier may need to deliver to customers so that they can maintain healthy and efficient landscapes across the supplier's service area." (See footnote 6). The Conservation Regulation sets this factor for CII w/ DIMs at 0.80 from adoption to 2035; 0.63 from 2035 to 2040; and 0.45 from 2040 onward, implying reductions of 20 percent, 37 percent, and 55 percent from historical uses, respectively. Suppliers can obtain credits for irrigation with recycled water that reduce these apparent reductions. Therefore, reductions of 20 percent in 2030, 35 percent in 2040, and 45 percent in 2045 are realistic.

- If the aggregate pumping rights are less than the projected aggregate pumping, then 80 percent of the replenishment obligation is debited to storage accounts with the remainder being satisfied through wet-water recharge. This assumption was based on historical assessment packages.

During Watermaster's annual data collection and evaluation process, Watermaster collects updated information regarding the parties' anticipated use of storage. The current information suggests that 90 percent of replenishment obligations are expected to be met through stored water in the future.

In 2024, Watermaster began developing a tool to project managed storage account balances for individual parties based on pumping projections, transfers, and other assumptions. As of this writing, the assumptions for transfers are not refined to a degree necessary to use the tool. Therefore, we will calculate managed storage and replenishment obligations on an aggregate basis for the 2025 SYR.

Water Plan Scenarios that Represent Uncertainty in Future Cultural Conditions

This section answers question 3 above: *How should the current plans and projections be modified to develop Water Plan scenarios that will represent the uncertainty in future cultural conditions?*

The following subsections describe the assumptions for each of Water Plan scenario for buildout, the Conservation Regulation, groundwater utilization, and imported water utilization. The three Water Plan scenarios are shown in Table 1 and include:

- Scenarios 1, 2, and 3
  (Expected Demands, Expected Groundwater Utilization, Expected Imported Water Utilization)
- Scenarios 4, 5, and 6
  (High Demands, High Groundwater Utilization, Low Imported Water Utilization)
- Scenarios 7, 8, and 9
  (Low Demands, Low Groundwater Utilization, High Imported Water Utilization)

Buildout

Buildout assumptions impact future land use conditions and Water Plans. Based on the information described above, the **expected demand** condition assumes land use buildout by 2040, coinciding with the agricultural pumping declining to 4,070 afy. The **high demand** condition assumes that buildout will occur in 2037. The **low demand** condition assumes that buildout will occur in 2045. The Water Plans for the high demand and low demand scenarios will be adjusted relative to the expected buildout in 2040.

Conservation Regulation

Based on the input from the parties, we have developed three plausible demand scenarios to simulate the degree that the parties' demands will decline due to the draft Conservation Regulation. In some cases, parties' water use in their Water Plans is less than the water use objective. In these instances, the demands shown in the compiled Water Plans were not adjusted. The three demand conditions assume the following regarding the Conservation Regulation:

- The **expected demand** condition assumes that major AP retailers will meet a minimum of 60 percent of the reductions required to meet nominal objectives in residential water uses and 80 percent of the reductions required to meet nominal objectives in CII w/DIMs.

- The **high demand** condition assumes that the Water Plans will reflect the compiled Water Plans. The compiled Water Plans reflect major AP retailers meeting a minimum of 35 percent of the reductions required to meet nominal objectives in residential water uses and 50 percent of the reductions required to meet nominal objectives in CII w/DIMs.
- The **low demand** condition assumes that major AP retailers will meet a minimum of 80 percent of the reductions required to meet nominal objectives in residential water uses and 90 percent of the reductions required to meet nominal objectives in CII w/DIMs.

The range in percentages are based on the assumptions that (1) parties will not be able to fully meet the nominal water use objectives and (2) proportional reductions in CII w/ DIMs will exceed that of residential uses.

Groundwater and Imported Water Utilization

The groundwater and imported water utilization conditions are as follows:

- The **expected groundwater and imported water utilization** condition reflects the compiled Water Plans adjusted for the assumed implementation of the Conservation Regulation. Parties are assumed to meet 90 percent of any replenishment obligations through debits from Managed Storage before purchasing imported water for wet-water recharge via Watermaster.
- The **high groundwater utilization/low imported water utilization** condition assumes that the proportion of total demands met by Chino Basin groundwater increase by four percent relative to the expected condition, and the proportion of total demands met by imported water declines by four percent. Parties are assumed to meet 100 percent of any replenishment obligations through debits from Managed Storage.
- The **low groundwater utilization/high imported water utilization** condition assumes that the proportion of total demands met by Chino Basin groundwater decline by four percent relative to the expected condition, and the proportion of total demands met by imported water increases by four percent. Parties are assumed to meet 70 percent of any replenishment obligations through debits from Managed Storage before purchasing imported water for wet-water recharge via Watermaster.

Aggregate Water Plans

Tables 3a, 3b, and 3c show the aggregate Water Plans for the three Water Plan scenarios for an average hydrologic year. The notable differences between the scenarios include:

- By 2045, total demands range from 339,000 af (low demand) to 374,000 af (high demand), with expected demands at 365,000 af.
- The percentage of Chino Basin groundwater utilization ranges from 39 percent (low groundwater utilization – 2040) to 52 percent (high groundwater utilization – 2045) of total demands, with expected groundwater utilization between 44 and 47 percent.
- The percentage of imported water utilization ranges from 21 percent (low imported water utilization – 2045) to 31 percent (high imported water utilization – 2040) of total demands, with expected imported utilization between 25 and 27 percent.

Variability due to Climate Scenarios

This section answers question 4 above: *How should the Water Plan scenarios be adjusted to account for climatic variability?*

We define climatic variability for the modeling as interannual or multi-year variability in precipitation and temperature. Demands respond to changes in precipitation and temperature (as reflected in changes in evapotranspiration). We consider the impacts of precipitation and temperature on demands to be independent.

Variability of Demands due to Precipitation

Demands typically decrease during wet years and increase during dry years, mainly because of the influence of precipitation on outdoor irrigation demands. These patterns are reflected in the historical data (Figure 2), where total demands in wet years are up to seven percent less than average, and the total demands in dry years are up to five percent greater than average.

During dry years/periods, increased demands for outdoor irrigation are expected to outweigh any reductions in demands due to water conservation measures. IEUA has estimated in its 2020 UWMP that longer dry periods (three or more years) could result in an increased demand by about nine percent by 2040.[14] These projections are consistent with other regional studies[15] and 2020 UWMPs.

Based on the historical data shown in Figure 2 and the available planning data, the interannual demands will fluctuate within 10 percent of the average demands, scaled on assumed precipitation conditions.

Variability of Demands due to Temperature

Changes in temperature and evapotranspiration drive changes in demands, primarily outdoor irrigation. IEUA has estimated that a 3.6-degree Fahrenheit (°F) increase in temperature may result in a 4.3 percent increase in demand (about 1.2 percent per °F).[16] The parties that have developed 2020 UWMPs incorporate assumptions for impacts of future climate change in demands pursuant to the California Water Code.[17] Therefore, we assume that the compiled Water Plans, most of which are based on the 2020 UWMPs, reflect the anticipated impacts of temperature on demands for the **expected climate scenario**. In the **hot/dry** and **cool/wet climate scenarios**, it is assumed that demands will increase and decrease, respectively, by 1.2 percent per °F of difference from the expected climate scenario, calculated on an average annual basis.

CLIMATE DATASETS AND SCENARIOS

The 2025 SYR is reevaluating the Safe Yield for the period from FY 2021 through 2030. Historical climate and cultural conditions will be simulated through FY 2023, with projected cultural conditions and climate beginning in FY 2024 and through the model simulation period (at least 50 years). This section provides an update on the processing of the climate projection datasets and describes the proposed climate scenarios.

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[14] Section 2.6 of IEUA's 2020 UWMP

[15] Miro, Michelle E., David G. Groves, David Catt, and Benjamin M. Miller, Estimating Future Water Demand for San Bernardino Valley Municipal Water District. Santa Monica, CA: RAND Corporation, 2018. https://www.rand.org/pubs/working_papers/WR1288.html.

[16] Table 2-3 of IEUA's 2015 IRP

[17] Appendix I. Considering Climate Change Impacts (ca.gov)

Datasets for Projected Climate Conditions

Scenario TM #2 documented the proposed downscaled Global Climate Model (GCM) datasets from Phase 6 of the Coupled Model Intercomparison Project (CMIP6) that we propose to use for the projection scenarios. Since Scenario TM #2, we have processed the precipitation and temperature datasets for the three climate models identified in TM #2 for all scenarios (i.e., historical, SSP2-4.5, SSP3-7.0, and SSP5-8.5) in the Chino Basin. Our proposed method for choosing models for the Projection Ensemble is as follows:

1. Compare the simulated precipitation and temperature time series from the three downscaled GCM datasets for the historical period (FY 1951 through 2014) to PRISM[18] data, which are assumed to represent observed precipitation and temperature conditions over the historical period. Based on this comparison, choose the GCM that is best able to match the observed data.
2. Compare statistics for each of the three projection scenarios of the chosen GCM to identify the GCM/projection scenario combinations that best represent the expected condition, a hot/dry condition, and a cool/wet condition.

Our initial data processing has identified some systematic discrepancies between the GCM and PRISM datasets for the historical period that Cal-Adapt is working to address as of this writing; therefore, we have not completed the historical period comparison to choose the appropriate GCM. A more complete analysis and recommendations will be described in a future draft of this TM. Based on our analysis of the datasets for projected climate conditions to date, we may consider revising the definition of the climate scenarios to align with the precipitation and temperature patterns of the projected conditions while ensuring that the full range in potential climate futures are simulated.

Proposed Climate Scenarios

This section describes the proposed method for generating projected precipitation and the proposed climate scenarios used in the 2025 SYR.

Generating Projected Climate Time Series

Our proposed approach is to base the projections for the current decade (FY 2024 through 2030) on historical (PRISM) hydrology and base the projections beyond FY 2030 on the CMIP6-generated precipitation. Annually, net recharge is more sensitive to year-to-year precipitation variability than to longer-term trends in average precipitation. Further, differences in climatic conditions resulting from different emission pathways can be expected to result in only a minor amount of uncertainty over the very near-term compared to natural interannual variation; the Safe Yield that is calculated over FY 2021 through 2030 will be sensitive to the simulated precipitation over the projection period of FY 2024 through 2030.

The projected precipitation datasets from the downscaled CMIP6 models reflect future climate trends, but the CMIP6-simulated interannual variability over the period of FY 2024 through 2030 may not adequately capture the possible range of precipitation over this period. Therefore, we propose a hybrid approach to projecting precipitation, where the precipitation for FY 2024 through 2030 uses a continuous seven-year period taken from historical data, and the precipitation for FY 2031 and beyond uses downscaled CMIP6 data. Precipitation data for FY 2024 through 2030 will be derived from the historical (PRISM) record of FY 1950 through 2022.

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[18] Parameter-elevation Relationships on Independent Slopes Model (PRISM) data are developed by the Northwest Alliance for Computational Science and Engineering at Oregon State University (PRISM Climate Group at Oregon State University).

Our proposed approach to generate the projected temperature time series is to use the downscaled CMIP6 datasets for the projected period. This approach is appropriate because (1) less interannual variability in temperature compared to precipitation and (2) the clear and systematic upward trend of historical temperatures over recent decades. Temperature patterns are more stable and predictable over time, making the use of model projections more reliable for temperatures than for more variable climate elements such as precipitation. Relying on historical temperature data to project future temperatures would be inappropriate, as it would fail to account for the continuing and accelerating increases in temperature.

Climate Scenarios

Table 4 shows the proposed climate scenarios and datasets to be used for portions of the projection period.

Table 4. Proposed Climate Scenarios

Climate Scenario	Precipitation		Temperature
	FY 2024 through 2030	FY 2031 and beyond	Entire Projection Period
Expected	Historical period with average precipitation[a]	SSP3-7.0 from selected GCM	SSP3-7.0 from selected GCM
Hot/dry	Historical period with lowest precipitation	SSP5-8.5 from selected GCM	SSP5-8.5 from selected GCM
Cool/wet	Historical period with highest precipitation	SSP2-4.5 from selected GCM	SSP2-4.5 from selected GCM

(a) Calculated based on continuous seven-year periods taken from the historical (PRISM) data of FY 1950 through 2022.

Figure 4 illustrates the historical precipitation from FY 1992 through 2023 and a hypothetical time series of future precipitation for the expected climate scenario for FY 2024 through 2075. The projected precipitation for FY 2024 through 2030 is identical to the precipitation from FY 1968 through 1974, which is the seven-year period with a mean precipitation closest to the mean of the historical period.

SCHEDULE AND NEXT STEPS

The June 25, 2024 workshop is the third stakeholder workshop that will aid the development of the scenarios that will be simulated during the 2025 SYR. The remaining schedule to complete the 2025 SYR scenario development is described below.

- **June 25, 2024 through July 19, 2024:**
  - Parties and stakeholders provide written comments on draft Scenario TM #3, and the Projection Ensemble.
  - West Yost continues to refine the climate data that will be used in the Projection Ensemble.
- **July/August 2024:**
  - West Yost and Watermaster respond to written feedback on the Projection Ensemble and Scenario TM #3. West Yost and Watermaster will revise draft Scenario TM #3 and distribute the revised draft to the parties.
  - West Yost and Watermaster conduct a follow-up workshop to present the revised draft Scenario TM #3 and gather additional feedback from the Parties.

- West Yost and Watermaster respond to written feedback on Projection Ensemble and Scenario TM #3. West Yost and Watermaster finalize Scenario TM #3 and distribute the TM to the parties.
- West Yost begins preparing projection realizations (Projection Ensemble and calibrated model realizations) for simulation with the 2025 CVM.

Next Steps

Following the June 25, 2024 workshop, Watermaster invites additional written input from the parties or other stakeholders that may assist the development of the Projection Ensemble. Please submit written input to Garrett Rapp at grapp@westyost.com by July 19, 2024

Table 3a. Aggregate Water Plans for Scenarios 1-3
(Expected Demands, Expected Groundwater Utilization,
Expected Imported Water Utilization)

Category	2025	2030	2035	2040	2045
Volume (afy)					
Chino Basin Groundwater	143,179	154,894	157,747	168,902	172,929
Non-Chino Basin Groundwater	54,682	55,077	55,371	55,762	55,954
Local Surface Water	13,205	13,205	13,205	13,205	13,205
Imported Water	87,113	87,903	88,430	90,914	91,584
Recycled Water for Direct Use	25,891	27,888	29,185	30,782	31,282
Total	324,070	338,967	343,937	359,565	364,954
Percentage					
Chino Basin Groundwater	44%	46%	46%	47%	47%
Non-Chino Basin Groundwater	17%	16%	16%	16%	15%
Local Surface Water	4%	4%	4%	4%	4%
Imported Water	27%	26%	26%	25%	25%
Recycled Water for Direct Use	8%	8%	8%	9%	9%
Total	100%	100%	100%	100%	100%

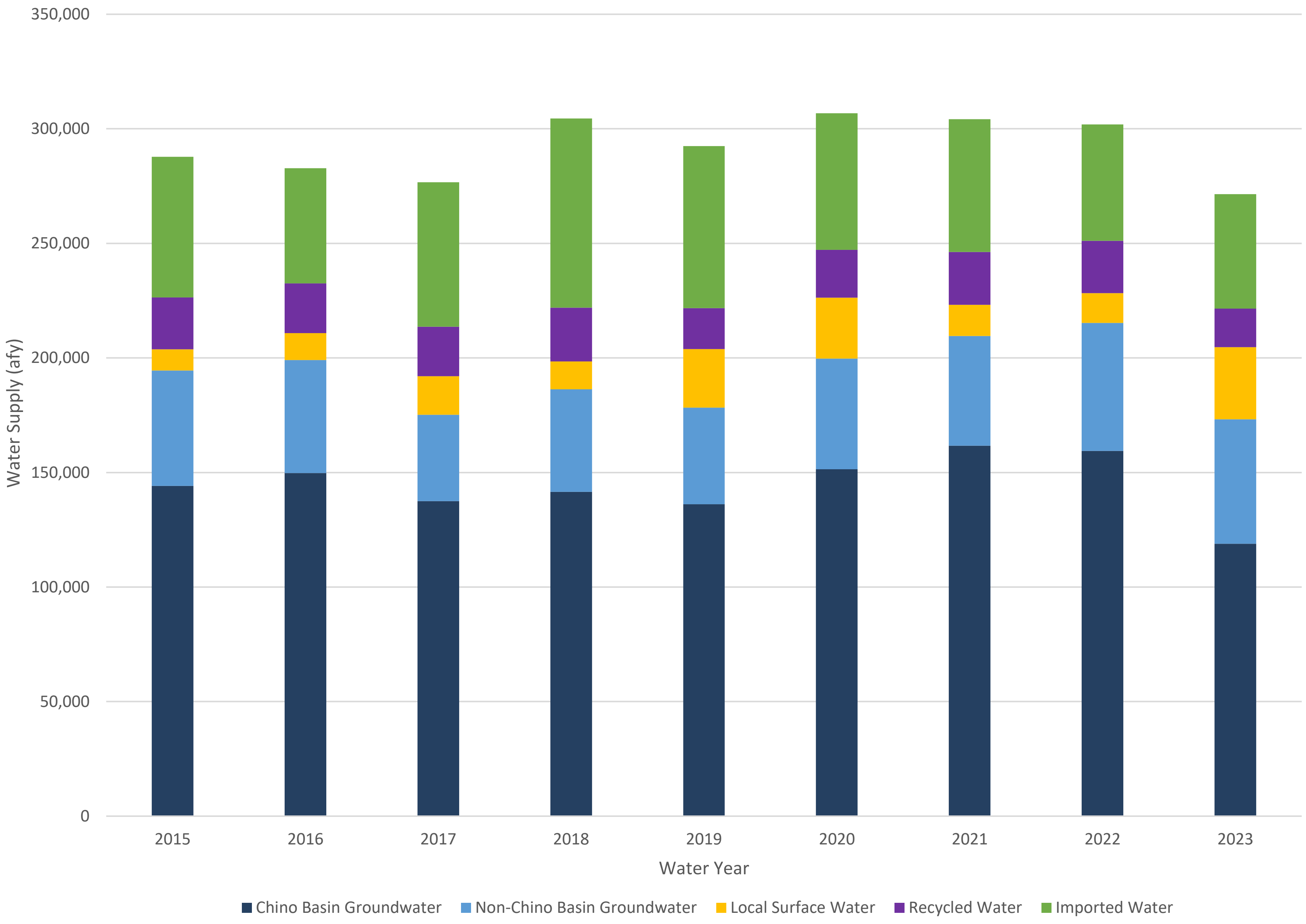
Table 3b. Aggregate Water Plans for Scenarios 4-6
(High Demands, High Groundwater Utilization,
Low Imported Water Utilization)

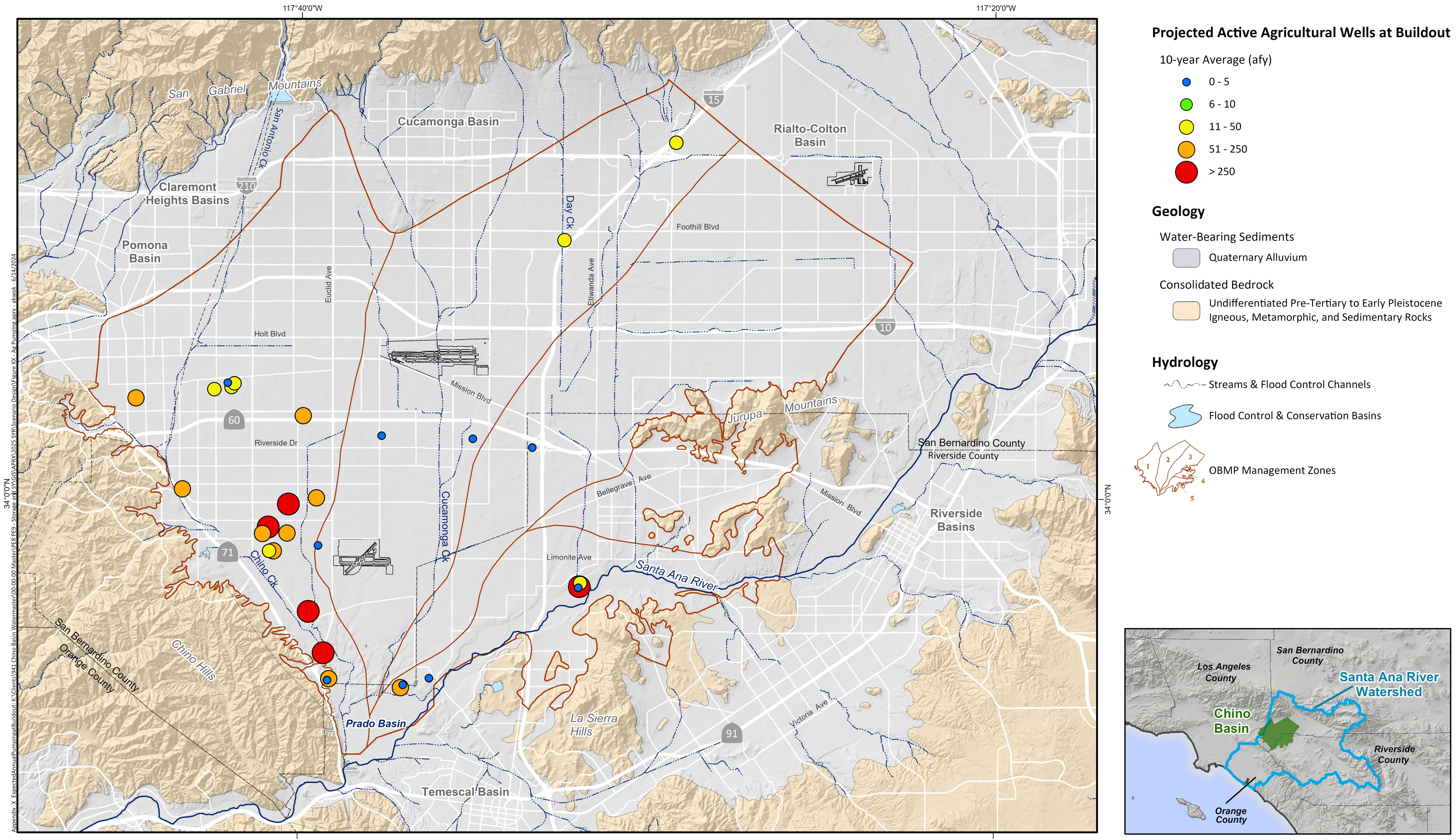
Category	2025	2030	2035	2040	2045
Volume (afy)					
Chino Basin Groundwater	156,142	169,322	177,366	189,808	193,830
Non-Chino Basin Groundwater	54,682	55,077	55,371	55,762	55,954
Local Surface Water	13,205	13,205	13,205	13,205	13,205
Imported Water	74,150	74,758	77,704	79,714	79,994
Recycled Water for Direct Use	25,891	27,888	29,185	30,782	31,282
Total	324,070	340,250	352,831	369,270	374,265
Percentage					
Chino Basin Groundwater	48%	50%	50%	51%	52%
Non-Chino Basin Groundwater	17%	16%	16%	15%	15%
Local Surface Water	4%	4%	4%	4%	4%
Imported Water	23%	22%	22%	22%	21%
Recycled Water for Direct Use	8%	8%	8%	8%	8%
Total	100%	100%	100%	100%	100%

Table 3c. Aggregate Water Plans for Scenarios 7-9
(Low Demands, Low Groundwater Utilization,
High Imported Water Utilization)

Category	2025	2030	2035	2040	2045
Volume (afy)					
Chino Basin Groundwater	130,216	134,291	132,078	128,150	134,135
Non-Chino Basin Groundwater	54,682	54,993	55,110	55,570	55,762
Local Surface Water	13,205	13,205	13,205	13,205	13,205
Imported Water	100,075	101,255	100,114	104,411	105,297
Recycled Water for Direct Use	25,891	27,517	28,120	30,282	30,782
Total	324,070	331,261	328,627	331,618	339,181
Percentage					
Chino Basin Groundwater	40%	41%	40%	39%	40%
Non-Chino Basin Groundwater	17%	17%	17%	17%	16%
Local Surface Water	4%	4%	4%	4%	4%
Imported Water	31%	31%	30%	31%	31%
Recycled Water for Direct Use	8%	8%	9%	9%	9%
Total	100%	100%	100%	100%	100%

Figure 2. Historical Water Supplies of the Chino Basin Parties, Water Year 2015 through 2023





Appendix X_ExpectedAnnualPumpingatBuildout: K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\PE8 PE9 - Storage and SY\GIS\APRX\2025 SYR\Scenario Design\Figure XX - Ag Pumping.aprx - akwok - 6/14/2024

Prepared by:

WEST YOST
Water. Engineered.

Author: AK

Date: 6/14/2024

N
0 3 6 Miles
0 4 8 Km

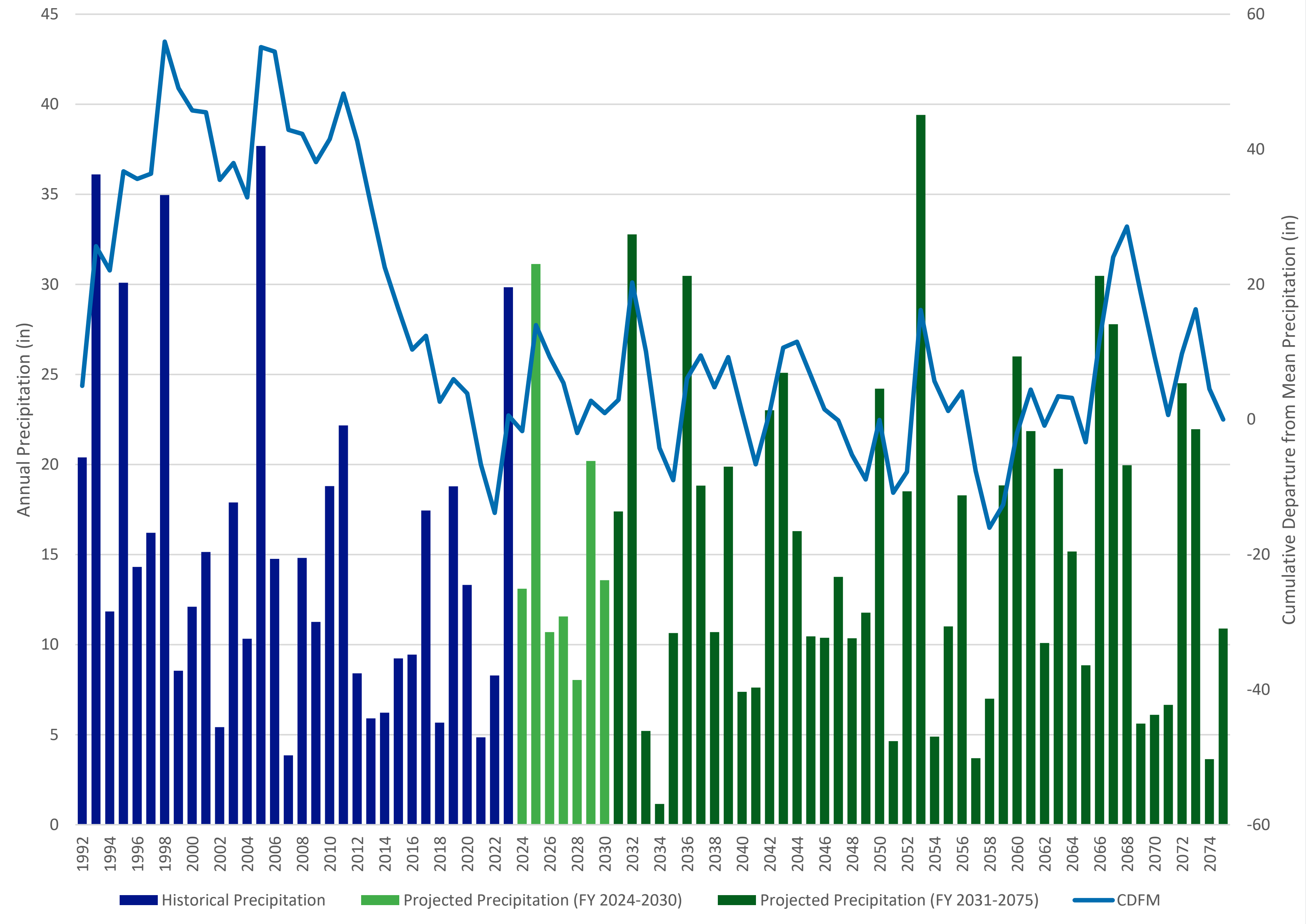
Prepared for:

Chino Basin Watermaster
2025 Safe Yield Reevaluation

Projected Active Agricultural Wells at Buildout

Figure 3

Figure 4. Hypothetical Precipitation Time Series for Expected Climate Scenario



WEST YOST

941-80-23-33

Chino Basin Watermaster
2025 Safe Yield Reevaluation
Last Revised: 06-20-24

Attachment A

Written Stakeholder Feedback:

Scenario Design TM #2 and Workshop #2

Garrett Rapp

From: Rees, Rick <richard.rees@wsp.com>
Sent: Friday, April 5, 2024 9:48 AM
To: Garrett Rapp; etellezfoster@cbwm.org
Cc: Carol Boyd; Marilyn Levin; Noah GoldenKrasner; 'Medrano, Jaime@CDCR'; 'Tariq.Awan@cdcr.ca.gov'; Imelda.Cadigal@cdcr.ca.gov; 'Diana Lee Frederick (Diana.Frederick@cdcr.ca.gov)'; Gregor.Larabee@cdcr.ca.gov; Callahan, Lewis@CDCR (Lewis.Callahan@cdcr.ca.gov); Mahmoud, Ayman@CDCR; Farrell, Jennifer@CDCR; Eric.Papathakis@cdcr.ca.gov; Stewart, Craig
Subject: Comments on 2025 Safe Yield Reevaluation - Scenario Design #2, March 7, 2024

Garrett and Edgar,

We reviewed the draft Technical Memorandum regarding “Design of Projection Scenarios to Support the 2025 Safe Yield reevaluation (#2)” (TM #2) dated March 5, 2024. On behalf of the State of California, a member of the Agricultural Pool, we have the following comments:

General Comment

The TM#2 describes the scenario designs in general and we have no comments on the elements of the water plan scenarios. The proposed projection scenarios are limited and appear to be balanced around the expected condition. We agree with that approach. We look forward to seeing the analysis and recommendations for the climate data sets in Scenario TM #3.

Specific Comment

Page 7, first paragraph, “Scripps Institute of Oceanography” should be “Scripps Institution of Oceanography.”

Rick Rees

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